

STRUCTURAL SYSTEMS

WHEN TO CONSIDER

NEEDS ASSESSMENT	NO	SCHEMATIC DESIGN	YES
MASTER PLANNING	NO	DESIGN DEVELOPMENT	YES
PROJECT STATEMENT	MAYBE	CONSTRUCTION	
ARCHITECTURAL		DOCUMENTS	DONE
PROGRAMMING	MAYBE	CONSTRUCTION	DONE
NO-Need not consider.			
MAYBE-This system may be considered.			
YES-This system should be considered.			
DONE-This system should have already been considered.			

DESCRIPTION

The structural system of your new facility keeps the building standing. Most of the other building components are attached to it. Typically, it is composed of beams, load bearing walls, roofs, columns, and floors. (The foundation system, also an integral part of a building's structure, is addressed separately because of specific criteria which affect foundation design.) Determination of what criteria for wind, live loads, dead loads, and seismic safety factors will affect the design substantially. Find out what your engineer is basing his design calculations on and perhaps obtain a second opinion on the appropriateness of these assumptions.

RELATIONSHIP TO OTHER SYSTEMS

The exterior closure and interior partitions of the building may act as structural components in helping support floors and roofs or in providing lateral support.

Because many interior and exterior walls of a correctional facility are constructed of substantial materials for security purposes, they can and should be used for structural purposes also. A structural design which ignores the usefulness of walls in helping to support roofs and floors is redundant and, therefore, not cost effective. Although interior and exterior walls will often be a part of your structural system, they are addressed separately because of other cost considerations particular to their use as walls.

ALTERNATIVES

Precast Concrete

Precast concrete consists of concrete members cast at an offsite precast plant and trucked to the site for installation or cast on site and put in place with a crane.

If used in the right places, precast concrete can be a good solution for a reasonable price. Because it is not inexpensive and is subject to wide price swings depending on how it is used, it can be a very expensive solution. Some of the advantages and disadvantages of precast concrete are:

- Prices can be very competitive with other systems when you use numerous pieces of the same size and shape. One of the most costly aspects of a precast system is the initial cost of making the forms. Once the forms are made, each additional piece becomes less expensive.
- Precast concrete can save time because it is fabricated in a plant where weather conditions do not affect production. Once trucked to the site, it can be erected extremely rapidly. To take advantage of this, make sure the building components are designed from a constructability perspective. Consider the sizes of pieces relative to trucking and erection with a crane and how the erectors in the field will be putting the building together.
- The inherent nature of concrete eliminates the need for fire proofing or additional finishes for durability.
- To achieve the maximum potential from precast concrete, keep the number of different pieces to a minimum and the shape of each piece as simple as possible. Every corner, reveal, embed, etc. adds to the cost of each piece.
- Consider the local market when specifying precast. The material must be trucked from the plant to the site, so trucking costs must be considered. Also, if the amount of precast is not significant, the interest from the precast industry may be minimal - a lack of competition can drive up costs.
- When considering floor or roof planks, a number of "off-the-shelf" panels are available. Usually these are less expensive than custom pieces.

Cast-In-Place Concrete

Cast-in-place concrete consists of concrete which is poured into forms, onto decking, or on the ground at its final location in the building.

Although cast-in-place concrete has many typical uses (such as slabs on grade or topping for roof and floor decks), this use of concrete is probably the most expensive and the slowest of structural systems available. But, because of correctional facility security concerns, cast-in-place concrete can sometimes be an economical solution for parts of the building. Most commonly, cast-in-place concrete structural components are used for parts of the building which are difficult to manufacture off the site or to construct with steel because of irregular shapes or fireproofing/durability needs of the finished product.

Cast-in-place concrete can be a competitive solution for highrise buildings if the structural components also are used for floor, ceiling and wall components. The key to an economical design of a high-rise cast-in-place concrete structure is to consider how the building will be constructed, targeting a minimalization of the system's labor intensiveness. One common practice with high-rise

concrete structures is to use "slip forming" of floor slabs where the same forms are used for each floor and then moved to the floor above after the concrete cures. Design of interior walls and supporting columns and beams must be considered carefully in such an application.

Tilt-Up Concrete

(See exterior enclosures as this system is primarily a wall system which can double as a structural system.)

Steel

Steel, as used in a structural system, typically consists of steel beams, columns and floor and roof decks. Concrete topping typically is poured over steel floor decking as a structural part of the floor system and as the substrate for floor finishes. Roof decks may or may not have concrete topping, depending on fireproofing and spacing of beams which support the roof deck.

Some of the advantages and disadvantages of structural steel within a correctional facility include:

- Structural steel generally is more economical as a framing system than concrete.
- Structural steel typically takes less time than concrete to fabricate and erect.
- Steel is a more economical means of spanning open spaces such as dayrooms.
- Steel is a very durable material if detailed properly.
- One disadvantage is the need to fireproof structural members in many instances, although this cost alone doesn't make it more expensive than concrete. It becomes more expensive when the fireproofing also must be covered by expensive finish systems that are accessible to inmates. The cost can be more than concrete.

Pre-Engineered Metal Buildings

As implied by the name, this building system uses standardized metal components which are engineered to maximize use of the material's structural properties. This system typically is offered as a complete building package, including structure, metal roof and metal wall panels. (Tilt-up concrete walls can be used on a pre-engineered building also.) Because it's already been designed very close to its limit, the building system is meant to be used without modifying a manufacturer's standard design if you are to achieve the cost benefits of the system.

Pre-engineered metal buildings are not recommended for areas where the building itself provides the security enclosures because the metal wall and roof panels are light gauge. They are very durable, however, having a 20 to 30-year life span.

If used in areas where vehicle, forklift or materials are in motion, the metal siding should be protected with plywood wainscot, steel bumpers, etc. These buildings are not adaptable to areas which require fireproofing.

This is probably the least expensive quick way to enclose large areas, but the use must fit this system because it is very difficult to modify.

Wood

This structural system consists of wood columns, beams and framing for floors, roofs and walls, as commonly found in smaller commercial or residential buildings of up to three floors.

It is relatively inexpensive for non-fire resistive construction buildings which do not have strict security requirements and which are similar to wood framing found in the private sector. Wood construction is more common with local, smaller commercial contractors who typically do not bid on concrete or steel buildings.

Good for non-secure areas as discussed below.

If a substantial part of your facility is strictly administrative or serves some function other than security, a wood structure may be more economical than steel or concrete alternatives.

Structural Matrix

		ALTERNATIVES							
		PRECAST CONCRETE	CAST-IN-PLACE CONCRETE	TILT-UP CONCRETE	STRUCTURAL STEEL	PRE-ENGINEERED METAL	WOOD		
CRITERIA	COST								
	SECURITY								
	DURABILITY								
	SCHEDULE								